IDEAL GAS LAWS

Day 1 and 2: Gas laws

1. a. Compare between real and ideal gas. Under what conditions oxygen gas behaves as an ideal gas?
   b. Do you expect the gas in cooking gas cylinder to obey the ideal gas equation? Explain.
   c. State Boyle's law and Charles law. Interpret the laws using PV diagram.
   d. When a car is driven some distance, the air pressure in the tyre increases. Why?
   e. Why does a cycle tyre burst in summer?
   f. A cylinder of volume 40 litres is filled with air to a pressure of $200 \times 10^3 Pa$. A piston is then compressed to a volume of 2.5 litres. Calculate the pressure of the compressed gas? [Ans: $\mathbf{3.2 \times 10^5\ Pa}$]
2. a. Deduce ideal gas equation by combining Boyles and Charles laws.
   b. A gas at 27^oC in a cylinder has a volume of 4 litres and pressure $100Nm^{-1}$. Then the gas is compressed at constant temperature, so that the pressure is $150Nm^{-2}$. It is then heated at constant volume, so that temperature becomes 127^oC. Calculate new pressure. [Ans: $\mathbf{200Nm^{-2}}$]
   c. Write equation of state for an ideal gas. Find the number of molecules and the number of moles in one cubic meter of air at 1 atm pressure and 0^oC. [Ans: $\mathbf{2.68 \times 10^{25}\ molecules}$]
   d. A gas in a cylinder has a mass of 10Kg and pressure of 8 atm at 27^oC. When some gas is used in cold room at -3^oC, the gas remaining in the cylinder at this temperature has a pressure of 6.4 atm. Calculate the mass of gas used. [Ans: $\mathbf{1.1Kg}$]
   e. The correct inflation of tyre at 20^oC is 2 Kg/cm^2. After driving several hours, the driver checks the tyres. If the tyre's temperature is 50^oC, what should be the pressure reading? [Ans: $\mathbf{2.2 \times 10^5 N/m^2}$]

Day 3 and 4: Expansion of gas/ Kinetic theory of gas

3. a. Define universal gas constant. Write its unit and dimension.
   b. Write the physical significance of universal gas constant.
   c. Which has more molecules: 1Kg of Hydrogen or 1 Kg of oxygen?
   d. What is Avogadro's number? Is there same number of atoms in 1 mole of hydrogen (H_2) and 1 mole of helium (He)?
   e. Define volume coefficient and pressure coefficient of gas. How volume coefficient and pressure coefficient are related?
   f. Two bulbs of equal volume are joined by a narrow tube and are filled with gas at STP. When one bulb is kept in melting ice and the other in boiling water, calculate the new pressure of the gas. [Ans: $\mathbf{877.6\ mm\ of\ Hg}$]
4. a. Write the postulates of kinetic theory of gases. Derive the expression for pressure exerted by gas on the wall of a cube.
   b. Starting from pressure equation, obtain an expression for (i) Average translation kinetic energy of molecule of gas (ii) Average translational kinetic energy of gas.
   c. Calculate the total translational KE of the molecules of 5 moles of an ideal gas at 127^oC. [Ans: $\mathbf{1.49 \times 10^4 J}$]
   d. What is the average translational kinetic energy of an oxygen molecule at a temperature of 300K? [Ans: $\mathbf{6.23 \times 10^{-21} J}$]
   e. Calculate the total translational kinetic energy of 3 moles of gas at 227^oC. [$R = 8.31\ Jmol^{-1}K^{-1}$] [Ans: $\mathbf{1.87 \times 10^4 J}$]
   f. Will the temperature of gas in a container increase when we put the container on a moving train? Explain.

Day 5 and 6: Kinetic theory of gas

5. a. Define root mean square speed of gas. Why rms speed of hydrogen and oxygen are different at the same temperature?
   b. The rms speed of hydrogen at 27^oC is 1800m/s. What will be the rms speed of oxygen at 127^oC? [Relative molecular masses of hydrogen and oxygen are 2 and 32 respectively] [Ans: **519.6 m/s**]
   c. Calculate the rms speed and average KE of a molecule of oxygen gas at a temperature of 27^oC. [Ans: $\mathbf{44.4m/s, 6.23 \times 10^{-21} J}$]
   d. Calculate the temperature at which the rms speed of hydrogen molecule will be 11Km/s. [$R = 8.31 J/molK$] [$\mathbf{9446^oC}$]
   e. Find the rms speed of nitrogen molecules at 273K and 1atmospheric pressure. Density of nitrogen at this condition is $1.25 \times 10^{-3} gm/cm^3$. [Ans: **93m/s**]
6. a. Three different cylinders contain different gases H_2, O_2, N_2 at the same temperature. Which one of the above gas has maximum rms speed?
   b. An ideal gas is contained in a cylinder at a temperature of 27^oC. What is the average translational KE of a molecule? What is the total random translational kinetic energy of the molecules in 1 mole of this gas? What is the rms speed of oxygen molecules at this temperature? [Relative molecular mass of oxygen is 32. [$R = 8.31\ Jmol^{-1}K^{-1}$] [Ans: $\mathbf{1.24 \times 10^{-20} J, 3739.5 J, 484.4 m/s}$]
   c. At what temperature will the average speed of oxygen molecules be sufficient to escape from the earth? [Given, escape velocity from earth$11.2Km/s$, mass of one oxygen molecule$= 53.4 \times 10^{-24} gram$] [Ans: $\mathbf{161496.4K}$]